

COMP ENG 2D14
Logic Design

COURSE OUTLINE

Please refer to course website for updated information.

CALENDAR/COURSE DESCRIPTION

Binary numbers and codes; Boolean algebra; combinational circuit design; electrical properties of logic circuits; sequential circuit design; computer arithmetic; programmable logic; CPU organization and design.

PRE-REQUISITES AND ANTI-REQUISITES

Prereq(s): Registration in a program in Computer Engineering, Electrical Engineering, Engineering Physics (Photonics Engineering Stream) or Physics
Antireq(s): COMPSCI 2MF3, ELECENG 2D14, SFWRENG 2D03, 2D04, 2DA3, SFWRENG 2DA4

SCHEDULE AND MODE OF DELIVERY

The material for this course will be delivered through a mixture of online videos, textbook readings, live Q&A sessions during lecture time slots, and virtual laboratories. All of the usual in-class material will be made available online as pre-recorded videos. Students must watch the videos before attending the lecture sessions. In the online lecture sessions, we will have a live question & answer period related to the current material or any previous class material. The platform for each component is noted at the end of each line.

Section C01:

Lectures: Monday, Wednesday, Thursday, 5:30pm – 6:20pm (on Microsoft Teams)

Section C02:

Lectures: Tuesday, Thursday, Friday, 11:30am – 12:20pm (on Microsoft Teams)

Both Sections:

Tutorial: Thursday 1:30pm – 2:20pm (on Microsoft Teams)

Labs: There are 5 virtual labs in this class, which run for two weeks each. All students will submit their completed lab report by 5:30pm on the Friday of the second week of the lab. Students can work on labs at their own pace. TAs will be available online on Microsoft Teams Mon-Fri from 2:30pm to 5:30pm to answer questions regarding the lab. If students need help from a TA, they must attend the online lab session related to their lab section, where the lab section schedule will

be posted on Avenue To Learn. Thus, students should start work on their lab before their scheduled online lab session, so they can make the most use of this lab session.

INSTRUCTORS

Section C01:

Dr. Jennifer Bauman

Email: Jennifer.bauman@mcmaster.ca

Office: ITB-A217

Phone: 905-525-9140 ext. 27784

Office Hours: Email for an appointment

Section C02:

Dr. T. E. Doyle

Email: doylet@mcmaster.ca

Office: ETB-106

Phone: 905-525-9140 ext. 27784

Office Hours: Email for an appointment

Ensure your email subject starts with "COE2DI4: " and include in the body of the message your name, student number, lab section, and lecture section. Please include prior correspondence and endeavour to keep your emails concise. You must send emails from your @mcmaster.ca account.

Please note that during the university closures due to Covid-19 in the Fall Term, instructors will not be in their offices. Please see the course website for clarification on their availability.

TEACHING ASSISTANT OFFICE HOURS AND CONTACT INFORMATION

TA names and contact information will be available in the Week 1 lecture notes posted on Avenue to Learn. You can contact a TA for questions relating the labs, homework, and lecture material.

COURSE WEBSITE

The Course Management System (CMS) will be Avenue to Learn. The student is required to **check the system daily** for assignment release/submission, course related material, and posted announcements.

<http://avenue.mcmaster.ca/>

COURSE OBJECTIVES

By the end of this course, students should be able to:

- Manipulate and simplify Boolean expressions
- Analyze combinational and sequential logic designs
- Synthesize combinational and sequential logic designs
- Design and implement combinational and sequential logic circuits
- Use a hardware description language to implement digital logic design
- Analyze and design digital error detection
- Discuss computer organization in relation to digital systems
- Discuss the impact of digital system design on society

ASSUMED KNOWLEDGE

Successful completion of first year engineering. Students are expected to be proficient in first year engineering mathematics and computation. Students will be required to install course software on their personal computer.

COURSE MATERIALS

All course materials are available through the Titles bookstore or online.

Required items:

1. Textbook: ``*Digital Design: With an Introduction to Verilog HDL, VHDL, and System Verilog*`, 6th edition by M. Morris Mano

Optional Items:

1. The following text is recommended as a reference for technical writing – “*Technical Communication: Principles and Practice, Third Edition*” by Raman and Sharma.
2. The following book is suggested to students for supplemental independent reading - ``*Ones and Zeros: Understanding Boolean Algebra, Digital Circuits, and the Logic of Sets*`, by John Greg.

Calculator: No calculator permitted on tests or exams.

COURSE OVERVIEW

Lectures are complemented by the labs and tutorials. Students should watch the pre-recorded lecture videos prior to attending the virtual lecture sessions so the class can have a good discussion and Q&A regarding the lecture material. To take full advantage of the lecture time, the student must keep up with assigned readings and do the assigned problems. Lectures will

be initially focused on theory and then transition into a more balanced theory-application presentation. The lecture time will not be used to teach the software applications (this is done in lab and tutorial). The following is anticipated to be the weekly topic in lectures with associated readings. Based upon the lecture feedback, timing and order may be modified.

Date/Week	Topic
1	Introduction, Number Systems, Boolean Algebra, Logic Gates
2	Gate Level Minimization
3	Combinational Logic: Circuit Analysis and Design, Multiplexers, Adders, Encoders/Decoders
4	Hardware Description Language
5	Synchronous Sequential Logic: Analysis, Latches, Flip-Flops
6	Synchronous Sequential Logic: Analysis, Mealy and Moore Models
	Term Break
7	Synchronous Sequential Logic: Synthesis
8	Synchronous Sequential Logic: Synthesis
9	Digital Systems, Digital Data Error Detection
10	Computer Organization, Memory
11	Register Transfer Level Design
12	Introduction to Assembly
13	Review

Refer to Avenue for assigned reading and questions (CompEng 2DI4 Schedule). At certain points in the course it may make good sense to modify the schedule. The instructor may modify elements of the course and will notify students accordingly (on the course website).

LABORATORY OPERATION

Each student in the course is required to pass the lab safety quiz prior to attempting any of the laboratories. The video and quiz will be on Avenue to Learn.

There are 5 virtual labs in this course. Labs must be completed in groups of 1 or 2 students, with group member names marked clearly on the lab title page. A laboratory exercise deemed to be partially or fully copied will be considered an academic offence and be subject to the terms laid out under the McMaster Academic Integrity Policy. Lab details and schedule will be posted in the Week 1 lecture notes on Avenue.

	Topic
Lab 1	Logic Gates
Lab 2	Combinational Logic
Lab 3	Programmable Logic
Lab 4	Sequential Logic
Lab 5	Design and Implementation of Synchronous Sequential System

Please be aware of the following penalties for lab work:

1. Failure to properly upload and submit your lab report will result in being assigned a 0 for that evaluation. **This means ALL files necessary to evaluate your work.**
2. Failure to submit a lab report by the specified time will result in a 20% penalty up to two minutes late and 100% if more than two minutes.

For example, failure to submit your lab report, code, designs, etc. after completing a lab exercise will result in a grade of 0 for the entire lab (not just a 0 for the marks associated with missing piece(s)).

ASSESSMENT

Component	Weight
Lab Evaluation	25%
Midterm Exam	30%
Final Exam	45%
Total	100%

The final exam must be written else a final grade of F will be awarded with the notation DNW (Did Not Write). To pass the course you must obtain at least 50% on the final examination. Statistical adjustments (such as bell curving) will not normally be used. If the midterm is not written, or a student achieves a higher grade on the final exam, the midterm mark will be replaced by the final exam mark.

In a case where the component weight cannot be fulfilled as a result of unforeseen and/or uncontrollable circumstance(s) in the course operation or execution, the grades assigned to that component may be pro-rated.

See Avenue for dates, times, and instructions for Midterm Exam and Final Exam.

No make-up midterm tests will be granted. Weight of a missed midterm test will be transferred to final exam. Unless otherwise stated, tests, labs, and examinations are closed-book.

ACADEMIC INTEGRITY

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity. It is your responsibility to understand what constitutes academic dishonesty. Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the

university. For information on the various types of academic dishonesty please refer to the Academic Integrity Policy, located at <https://secretariat.mcmaster.ca/university-policies-proceduresguidelines/>

The following illustrates only three forms of academic dishonesty:

- plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.
- improper collaboration in group work.
- copying or using unauthorized aids in tests and examinations.

AUTHENTICITY / PLAGIARISM DETECTION

Some courses may use a web-based service (Turnitin.com) to reveal authenticity and ownership of student submitted work. For courses using such software, students will be expected to submit their work electronically either directly to Turnitin.com or via an online learning platform (e.g. A2L, etc.) using plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

Students who do not wish their work to be submitted through the plagiarism detection software must inform the Instructor before the assignment is due. No penalty will be assigned to a student who does not submit work to the plagiarism detection software. All submitted work is subject to normal verification that standards of academic integrity have been upheld (e.g., on-line search, other software, etc.). For more details about McMaster's use of Turnitin.com please go to www.mcmaster.ca/academicintegrity.

COURSES WITH AN ON-LINE ELEMENT

Some courses may use on-line elements (e.g. e-mail, Avenue to Learn (A2L), LearnLink, web pages, capa, Moodle, ThinkingCap, etc.). Students should be aware that, when they access the electronic components of a course using these elements, private information such as first and last names, user names for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in a course that uses on-line elements will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure please discuss this with the course instructor.

Some courses may use online proctoring software for tests and exams. This software may require students to turn on their video camera, present identification, monitor and record their computer activities, and/or lock/restrict their browser or other applications/software during tests or exams. This software may be required to be installed before the test/exam begins.

COPYRIGHT AND RECORDING

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and

copyright law protect every original literary, dramatic, musical and artistic work, including lectures by University instructors.

The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

CONDUCT EXPECTATIONS

As a McMaster student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all of our living, learning and working communities. These expectations are described in the Code of Student Rights & Responsibilities (the “Code”). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, whether in person or online. It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, WebEx or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students’ access to these platforms.

ACADEMIC ACCOMMODATIONS

Students with disabilities who require academic accommodation must contact Student Accessibility Services (SAS) at 905-525-9140 ext. 28652 or sas@mcmaster.ca to make arrangements with a Program Coordinator. For further information, consult McMaster University’s Academic Accommodation of Students with Disabilities policy.

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the RISO policy. Students should submit their request to their Faculty Office normally within 10 working days of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

REQUESTS FOR RELIEF FOR MISSED ACADEMIC WORK

McMaster Student Absence Form (MSAF): In the event of an absence for medical or other reasons, students should review and follow the Academic Regulation in the Undergraduate Calendar “Requests for Relief for Missed Academic Term Work”.

EXTREME CIRCUMSTANCES

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email.

RESEARCH ETHICS

The two principles underlying integrity in research in a university setting are these: a researcher must be honest in proposing, seeking support for, conducting, and reporting research; a researcher must respect the rights of others in these activities. Any departure from these principles will diminish the integrity of the research enterprise. This policy applies to all those conducting research at or under the aegis of McMaster University. It is incumbent upon all members of the university community to practice and to promote ethical behaviour. To see the Policy on Research Ethics at McMaster University, please go to <http://www.mcmaster.ca/policy/faculty/Conduct/ResearchEthicsPolicy.pdf>.

ACCREDITATION LEARNING OUTCOMES

Note: The *Learning Outcomes* defined in this section are measured throughout the course and form part of the Department’s continuous improvement process. They are a key component of the accreditation process for the program and will not be taken into consideration in determining a student’s actual grade in the course. For more information on accreditation, please ask your instructor or visit: <http://www.engineerscanada.ca> .

Outcomes	Indicators	Measurement Methods(s)
Demonstrates an ability to identify a range of suitable engineering fundamentals (such as Boolean Algebra, Karnaugh maps, etc.) to analyze and solve for the minimized form of a digital combinational circuit.	2.2	Assess implementation of practical lab circuit
Demonstrates an ability to identify a range of suitable engineering fundamentals (such as State Assignment, State Reduction, etc.) to analyze and solve for the minimized form of a digital sequential circuit.	2.2	Assess implementation of practical lab circuit
Using specialized software and hardware to demonstrate designing, building and troubleshooting digital combinational and sequential circuits.	5.2	Assess HDL implementation of lab 3 circuits

Understand the differences between Mealy and Moore sequential design and be able to correctly choose based upon application.	3.1	Assess design and rationale for implementation of lab 4 circuit
Discuss the local and global implications of sustainability in a digital system design.	9.1	Written response

Electrical and Computer Engineering Lab Safety

Information for Laboratory Safety and Important Contacts

This document provides important information for the healthy and safe operation of ECE instructional laboratories. This document is required reading for all laboratory supervisors, instructors, researchers, staff, and students working in or managing instructional laboratories in ECE. It is expected that revisions and updates to this document will be done continually. A McMaster University lab manual is also available to read in every laboratory and online <https://hr.mcmaster.ca/app/uploads/2019/07/2019-McMaster-Lab-Manual.pdf>

General Health and Safety Principles

Good laboratory practice requires that every laboratory worker and supervisor observe the following whether conducting lab work at school or at home:

1. Food and beverages are not permitted in the instructional laboratories.
2. A Laboratory Information Sheet on each lab door identifying potential hazards and emergency contact names should be known.
3. Laboratory equipment should only be used for its designed purpose.
4. Proper and safe use of lab equipment should be known before using it.
5. The course TA leading the lab should be informed of any unsafe condition.
6. The location and correct use of all available safety equipment should be known.
7. Potential hazards and appropriate safety precautions should be determined, and sufficiency of existing safety equipment should be confirmed before beginning new operations.
8. Proper waste disposal procedures should be followed.
9. Personal ergonomics should be practiced when conducting lab work. <https://bit.ly/3fOE71E>
10. Current University health and safety issues, and protocol should be known. <https://hr.mcmaster.ca/resources/covid19/workplace-health-and-safety-guidance-during-covid-19/>

Location of Safety Equipment

Fire Extinguisher

On walls in halls outside of labs

First Aid Kit

ITB A111, or dial "88" after 4:30 p.m.

Telephone

On the wall of every lab near the door

Fire Alarm Pulls

Near all building exit doors on all floors

Who to Contact

Emergency Medical / Security: On McMaster University campus, call Security at extension 88 or 905-522-4135 from a cell phone.

Non-Emergency Accident or Incident: Immediately inform the TA on duty or Course Instructor.

University Security (Enquiries / Non-Emergency): Dial 24281 on a McMaster phone or dial 905-525-9140 ext. 24281 from a cell phone.

See TA or Instructor: For problems with heat, ventilation, fire extinguishers, or immediate repairs

Environmental & Occupational Health Support Services (EOHSS): For health and safety questions dial 24352 on a McMaster phone or dial 905-525-9140 ext. 24352 from a cell phone.

ECE Specific Instructional Laboratory Concerns: For non-emergency questions specific to the ECE laboratories, please contact 24103.

In Case of a Fire (On Campus Dial 88)

When calling to report a fire, give name, exact location, and building.

1. Immediately vacate the building via the nearest Exit Route. Do not use elevators!
2. Everyone is responsible for knowing the location of the nearest fire extinguisher, the fire alarm, and the nearest fire escape.
3. The safety of all people in the vicinity of a fire is of foremost importance. But do not endanger yourself!
4. In the event of a fire in your work area shout "*Fire!*" and pull the nearest fire alarm.
5. Do not attempt to extinguish a fire unless you are confident it can be done in a prompt and safe manner utilizing a hand-held fire extinguisher. Use the appropriate fire extinguisher for the specific type of fire. Most labs are equipped with Class A, B, and C extinguishers. Do not attempt to extinguish Class D fires which involve combustible metals such as magnesium, titanium, sodium, potassium, zirconium, lithium, and any other finely divided metals which are oxidizable. Use a fire sand bucket for Class D fires.
6. Do not attempt to fight a major fire on your own.
7. If possible, make sure the room is evacuated; close but do not lock the door and safely exit the building.

Clothing on Fire

Do not use a fire extinguisher on people

1. Douse with water from safety shower immediately or
2. Roll on floor and scream for help or
3. Wrap with fire blanket to smother flame (a coat or other nonflammable fiber may be used if blanket is unavailable). Do not wrap a standing person; rather, lay the victim down to extinguish the fire. The blanket should be removed once the fire is out to disperse the heat.

Equipment Failure or Hazard

Failure of equipment may be indicative of a safety hazard - You must report all incidents.

Should you observe excessive heat, excessive noise, damage, and/or abnormal behaviour of the lab equipment:

1. Immediately discontinue use of the equipment.
2. In power labs, press wall-mounted emergency shut-off button.
3. Inform your TA of the problem.
4. Wait for further instructions from your TA.
5. TA must file an incident report.

Protocol For Safe Laboratory Practice

Leave equipment in a safe state for the next person - if you're not sure, ask!

In general, leave equipment in a safe state when you finish with it. When in doubt, consult the course TA.

Defined Roles

TA	The first point of contact for lab supervision	
ECE Lab Supervisor	Steve Spencer- ITB 147	steve@mail.ece.mcmaster.ca
ECE Chair	Tim Davidson- ITB A111	davidson@mcmaster.ca
ECE Administrator	Kerri Hastings- ITB A111	hastings@mcmaster.ca
ECE Course Instructor	Please contact your specific course instructor directly	

eng.mcmaster.ca/ece